New Hampshire Volunteer River Assessment Program

EXETER RIVER
1998 - 1999
Water Quality Monitoring Report

NEW HAMPSHIRE
DEPARTMENT OF
Environmental
Services

Acknowledgements

Many individuals contribute enthusiasm and dedication to the exploration and stewardship of New Hampshire rivers. The New Hampshire Department of Environmental Services extends sincere thanks to the volunteers and supporters participating in the Volunteer River Assessment Program:

- The volunteers give their time and energy toward the monitoring of water quality indicators and characteristics.

- The continued dedication of DES Commissioner Robert W. Varney enables volunteer monitoring support services to be extended across New Hampshire through DES lake and river assessment programs and partnerships.

- The DES Volunteer Lake Assessment Program serves as an overall model for the relatively new Volunteer River Assessment Program (VRAP). The University of New Hampshire Lakes Lay Monitoring Program, Great Bay Coast Watch, River Watch Network and the Merrimack River Watershed Council Volunteer Environmental Monitoring Network provide a wealth of experience and guidance for VRAP.

- The local organizations including Conservation Commissions, Regional Planning Commissions, schools, and municipal waste and drinking water treatment facilities contributing resources to citizen monitoring are helping to create sustainable citizen monitoring programs.

- A growing number of individuals, organizations, agencies and DES staff support VRAP by participating in monitoring activities, offering suggestions and initiating partnerships.

- The New Hampshire Estuaries Project (NHEP) and the DES Non-point Source, Ambient Sampling, and Source Water Protection programs augment volunteer efforts with funding and organizational support for monitoring projects.

- Senator Judd Gregg, for securing generous funding for VRAP equipment, is recognized as a supporter of volunteer monitoring efforts in New Hampshire and an advocate for natural resource protection.

1998 and 1999 Exeter River Volunteer Monitors

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Introduction

There are over ten thousand miles of rivers and streams in New Hampshire, stretching through our communities from the Canadian border all the way to the Atlantic Ocean. Healthy water resources are an indispensable part of our existence- we rely on clean water for drinking, recreational use, commercial and industrial supply. We also use surface waters for transportation purposes and as receiving waters for both industrial and municipal waste discharges. The development of land for residential, commercial and industrial purposes places additional pressure on surface waters. The New Hampshire Department of Environmental Services (DES) is charged with evaluating and regulating the quality of our surface waters, and is expanding its role in supporting and standardizing volunteer water quality monitoring to promote environmental monitoring and stewardship.

Since 1985 the DES Volunteer Lake Assessment Program (VLAP) has supported volunteer monitoring of New Hampshire lakes. VLAP volunteers collect water quality information about 130 lakes and ponds in New Hampshire each summer, contributing information about these waters that would otherwise be unattainable. The huge success and popularity of VLAP serves as a model for the Volunteer River Assessment Program (VRAP).

In New Hampshire there are watershed associations, local advisory committees and other established river interest groups sustained in a large part by volunteer efforts. Several of these groups have existing water quality monitoring programs and many have expressed interest in exploring and inventorying local water resources. VRAP ("vee-rap") was established in 1998 to provide support for these groups in the form of study design aid, technical assistance and training, loans of monitoring equipment, and data warehousing.

VRAP is an education and technical assistance program designed to support and coordinate volunteer monitoring of New Hampshire rivers. The main goals of VRAP are as follows:

- To educate the public about rivers and water quality;
- To organize groups to monitor water quality according to their goals;
- To provide monitoring guidelines, equipment loans, and technical training;
- To standardize data collection and management; and
- To report results and recommendations to volunteers.

General River Quality

The State Legislature classifies the New Hampshire surface waters according to what is known about their existing and historical quality and the uses they are required to support. The waters in each classification must satisfy all of the requirements of lower classifications. Currently there are two classes of surface waters in New Hampshire: Class A and Class B. According to the New Hampshire Revised Statutes Annotated (RSA 485-A:8):

> **"There shall be no discharge of any sewage or wastes into Class A waters, and these shall be considered as being potentially acceptable for water supply uses after adequate treatment."**
>
> **Class B waters "shall be considered as being acceptable for fishing, swimming and other recreational purposes and, after adequate treatment, for use as water supplies".**

State water quality officials monitor and regulate surface waters for compliance with the State of New Hampshire Surface Water Quality Regulations, set forth in RSA 485-A:8 and administrative rules Env-Ws 430. The overall goal is that all surface waters attain and maintain specified standards of water quality to achieve the purposes of the legislative classification. The DES Ambient Sampling Program conducts annual water quality sampling of rivers and streams in the state. Ambient samples represent the conditions of the water at the time they were taken and are analyzed for selected chemical and bacteriological parameters. The results are summarized in two reports: the annual DES Ambient Water Quality Report and the biennial 305(b) Report to Congress.

The annual data are presented and analyzed in the Ambient Water Quality Report. The results are used to:

- Evaluate attainment of New Hampshire water quality standards;
- Update baseline data used to determine long term water quality trends;
- Determine the capacity of receiving waters to assimilate waste loading;
- Assess potential toxic impacts;
- Determine the progress of restoration projects and Best Management Practices; and
- Determine if additional sampling is needed or where water quality violations exist.

In the 305(b) Report to Congress, the waterbodies not meeting their legislated classification are listed with the parameter in violation along with the probable source of the violation. This information is used on the federal level to determine where preservation, restoration and further assessment dollars will be spent across the country. Available funding is distributed among the states primarily through the United States Environmental Protection Agency (EPA) and constitutes the major source of funding our state water pollution control agency uses to accomplish water quality evaluation, restoration and preservation activities.

The DES Volunteer River Assessment program was established to augment water quality data collection efforts. VRAP aims to provide a mechanism for accessing local knowledge, creating reverence for water resources and increasing the volume and availability of information about New Hampshire rivers.

Monitoring Parameters

VRAP loans water monitoring kits that include meters and supplies for measuring five basic, or baseline, water quality parameters: water temperature, dissolved oxygen, pH, conductivity, and turbidity. Volunteers are trained to make measurements with these instruments at locations in the river that help pinpoint water quality assets and concerns. Baseline measurements repeated over time create a picture of the natural fluctuations in water quality and help to determine where improvements, restoration or preservation may benefit the river.

The investigation of additional parameters such as nutrients and bacteria is conducted by state water quality personnel and can be pursued by volunteer monitors. Sampling additional parameters comes with the cost of analysis, which can be covered by an assortment of fundraising activities such as grants, association membership fees, special events, or in-kind services, which are non-monetary contributions from individuals and organizations.

Below is a description and the environmental significance of some parameters typically sampled. New Hampshire Surface Water Quality Regulations are included where applicable to the following:

Temperature

Temperature is one of the most important and commonly observed water quality parameters. Temperature influences the rate of many physical, chemical and biological processes in the aquatic environment. Each aquatic species has a range of temperature and other factors that best support its reproduction and the survival of offspring. Temperature also impacts aquatic life because of its influence on other parameters, such as the concentration of dissolved oxygen in the water.

Temperature in Class B waters shall be in accordance with RSA 485-A:8, II, which states in part "any stream temperature increase associated with the discharge of treated sewage, waste or cooling water, water diversions, or releases shall not be such as to appreciably interfere with the uses assigned to this class."

Dissolved Oxygen

Adequate oxygen dissolved in the water is essential to the survival and successful reproduction of many aquatic species. Fish and other organisms use gills to transfer oxygen to their blood for vital processes that keep them active and healthy. Oxygen is dissolved into surface waters from the atmosphere, aided only by wind and wave action at the surface and by tumbling over rocks and uneven terrain. Aquatic plants and algae do produce oxygen in the water, but this contribution is offset by decomposition and respiration. Bacteria use oxygen as they process (decompose) plants and other organic materials in the river into smaller particles, and many aquatic organisms use oxygen in the process of respiration (breathing). Because of these natural processes oxygen levels are constantly changing and reflect a combination of factors.

Oxygen concentrations in water are measured using a meter that produces readings for both milligrams per liter and percent saturation of dissolved oxygen (DO). For Class B waters, any single DO reading must be greater than 5 mg/L for waters meeting New Hampshire water quality standards. This means that in every liter of water there are at least five milligrams of dissolved oxygen available for ecosystem processes.

More than one measurement of oxygen saturation taken in a twenty-four hour period can be averaged to compare with water quality standards. Class B waters must have a dissolved oxygen content of not less than seventy five percent of saturation, based on a daily average, to satisfy aquatic habitat requirements. The concentration of dissolved oxygen is dependent on many factors including temperature and sunlight, and tends to fluctuate throughout the day. Percent of saturation values are averaged because a reading taken in the morning may be low due to respiration, while a measurement that afternoon may show that the percent saturation has recovered to acceptable levels. Water can become saturated with more than one hundred percent dissolved oxygen, often observed below dams where the falling waters gather oxygen from the atmosphere.

There are other requirements in the New Hampshire administrative rules, Env-Ws 430, relative to cold water fish spawning areas, impoundments (dams), and reservoirs.

pH

pH is an indicator of hydrogen ion activity in water, measured on a logarithmic scale of zero to fourteen. The lower the pH, the more acidic the solution due to higher concentrations of hydrogen ions. A high pH is indicative of an alkaline or basic environment. Acid rain typically has a pH of 3.5 to 5.5. New Hampshire rivers have historically shown a range of pH values from 4.5 to 9. Most aquatic species require a

relatively stable pH between 5 and 9. The toxicity of aquatic compounds such as ammonia and certain metals is also affected by pH.

New Hampshire Surface Water Quality Regulations state that pH shall be between 6.5 and 8, unless naturally occurring. Often readings outside this range are determined to be naturally occurring because of the influence of wetlands near the sample site. In areas influenced by wetlands, tannic and humic acids released into the water by decaying plants can create acidic waters.

Conductivity

Conductivity is the numerical expression of the ability of water to carry an electric current. Formally termed specific conductance, conductivity is a measure of the free ion content in water. Water contains ions, or charged particles, such as magnesium (Mg^{2+}) and calcium (Ca^{2+}). These materials carry an electrical current and come from natural sources, such as soils and bedrock, or are introduced by human activity.

There is no standard for conductivity, because levels vary a great deal according to the geology of an area. Conductivity readings are useful in locating potential pollution sources because impacted surface waters usually have higher specific conductance than unimpaired waters. Conductivity tests can be used to indicate the potential presence of chlorides, nitrates, sulfates, phosphates, sodium, magnesium, calcium, iron, or aluminum ions, prior to any financial investment into analyzing specifically for these substances.

Turbidity

Turbidity is an indicator of the amount of suspended material in the water, such as clay, silt, algae, suspended sediment, and decaying plant material. A high degree of turbidity can interrupt the passage of light through the water and add heat to the water by absorbing sunlight. Clean waters are generally associated with low turbidity, but there is a high degree of natural variability involved. Rain events often contribute turbidity to surface waters by flushing sediment, organic matter and other materials from the surrounding landscape into surface waters.

Class B waters shall not exceed naturally occurring conditions by more than ten turbidity units (NTUs). In order to determine compliance with the water quality standards, information about background turbidity levels is needed. Volunteer data can be used to supplement data already collected by DES to help determine if turbidity is a problem in a particular watershed.

Bacteria

Organisms causing infections or disease (pathogens) are excreted in the fecal material of humans and other warm-blooded animals. *Escherichia coli* (*E. coli*) bacteria is not considered pathogenic. *E. coli* is, however, almost universally found in the intestinal tracts of humans and other warm blooded animals and is relatively simple and

inexpensive to measure. For these reasons *E. coli* is used as an indicator of fecal pollution and the possible presence of pathogenic organisms.

In fresh water *E. coli* concentrations help determine if the water is safe for recreational uses such as swimming. Class B waters shall contain no greater than 406 *E. coli* counts per one hundred milliliters CTS/100mL in any one sample, or not more than either a geometric mean based on at least three samples obtained over a sixty-day period of 126 *E. coli* (CTS/100mL).

Total Phosphorus

Phosphorus is a nutrient that is essential to plants and animals, but in excessive amounts it can cause rapid increases in the biological activity in water. This may disrupt the ecological integrity of streams and rivers.

Phosphate is the form of phosphorus that is readily available for use by aquatic plants. Phosphate is usually the limiting nutrient in freshwater streams, which means relatively small amounts of phosphate can have a large impact on biological activity in the water. Excess phosphorus can trigger algal blooms and aquatic plant growth. As a result, large amounts of decomposing organic material can decrease oxygen levels and the attractiveness of waters for recreational purposes.

Phosphorus can be an indicator of sewage, animal manure, fertilizer, erosion, and other types of contamination. There is no surface water quality standard for phosphorus due to the high degree of natural variability and the difficulty of pinpointing the exact source. However 0.05 mg/L total phosphorus is used as a level of concern, which means DES pays particular attention to readings above this level.

Metals

Depending on the metal concentration, its form (dissolved or particulate) and the hardness of the water, trace metals can be toxic to aquatic life. Metals in dissolved form are generally more toxic than metals in the particulate form. The dissolved metal concentration is dependent on the pH of the water, as well as the presence of solids and organic matter that can bind with the metal and render it less toxic. Hardness is primarily a measure of the calcium and magnesium ion concentrations in water, expressed as calcium carbonate. Higher hardness concentrations buffer the toxicity of certain metals. The metals standards are not detailed here due to their complexity.

Project Description

The Exeter River Local Advisory Committee (ERLAC) spearheaded the formation of a volunteer water quality monitoring program on the Exeter River in 1998. The *Exeter River Watershed Management Plan* recommends the establishment of a volunteer water quality monitoring program, and the volunteers enthusiastically joined VRAP when it

was first initiated.

Members of ERLAC, the Exeter Conservation Commission and other volunteers have been investigating the water quality of the Exeter River since 1998. The Town of Exeter has been very enthusiastic and supportive of the project, and volunteers are beginning to monitor locations upstream of Exeter. Refer to Appendix A for site locations and maps.

Results and Discussion

VRAP baseline parameters and bacteria results are reported by site, from upstream to downstream. Under each parameter heading (i.e. "Bacteria"), there is a code for the site indicating the number of samples collected that year and the number of samples that did not meet the water quality standard, where applicable. For example, if there were twelve samples collected at a site in 1999 and nine of them did not meet standards, the code would read as follows: "1999-12-9". Where there is no standard but a level of concern had been designated by DES, a narrative description of these conditions is given.

The sampling results upstream of Exeter did not reveal major impairments to water quality.

14-Ext. Pickpocket Road Bridge, Exeter, NH:

Dissolved Oxygen
1998-6-0 (< 5 mg/L minimum)

Dissolved oxygen (DO) concentration and percent saturation was monitored at 14-Ext every two weeks in the summer of 1998. All six samples measured above the required minimum instantaneous concentration of 5 mg/L, ranging from 7.55 to 9.26 mg/L.

1999-2-0 (< 5 mg/L minimum)

The DO concentrations in 1999 ranged from 7.63 to 8.23 mg/L, meeting the 5 mg/L minimum.

All of the samples in 1998 and 1999 had at least 75% saturation, meeting the criteria that support a healthy aquatic ecosystem. 14-Ext is located below a dam where the river is continually being aerated by spilling over the dam.

pH
1998-6-0 (unless naturally occurring)

The pH values recorded at 14-Ext ranged from 6.82 to 7.3, within the standard range for pH (6.5 to 8).

1999-2-0 (unless naturally occurring)

The pH values in 1999 ranged from 6.69 to 7.11, within the standard range for pH.

13-Ext. Kingston Road (Rte. 111) Bridge, Exeter, NH:

Dissolved Oxygen
1998-6-0 (< 5 mg/L minimum)
1999-2-0 (< 5 mg/L minimum)

All samples collected in 1998 and 1999 met the requirements of the New Hampshire Surface Water Quality Regulations.

pH
1998-6-0 (unless naturally occurring)

The pH values recorded at 13-Ext ranged from 6.95 to 7.26, within the standard range for Class B waters.

1999-2-0 (unless naturally occurring)

The pH values recorded in 1999 were between 7.01 and 7.09, within the standard range for Class B waters.

12a-Ext. Linden Street Bridge, Exeter, NH:

1998-6-0 (< 5 mg/L minimum)
1999-2-0 (< 5 mg/L minimum)

All samples collected met the requirements of the New Hampshire Surface Water Quality Regulations.

pH
1998-6-0 (unless naturally occurring)

The pH values recorded at 12a-Ext ranged from 6.74 to 7.14, within the standard range for Class B waters.

1999-2-0 (unless naturally occurring)

The pH values recorded in 1999 were within the standard range for Class B waters, from 6.69 to 7.25.

12-Ext. Route 108 Bridge, Exeter, NH:

Dissolved Oxygen
1998-5-0 (< 5 mg/L minimum)

The DO concentrations at this location ranged from 6.43 to 7.56 mg/L, all above the minimum concentration of 5 mg/L.

1999-2-0 (< 5 mg/L minimum)

The DO samples in 1999 ranged from 5.91 to 6.54 mg/L.

Extremely dry, low-flow conditions caused one of samples to measure below the 75% saturation requirement. Dissolved oxygen measurements ranged from 65.9 to 78.3% saturation. These readings suggest that for at least part of the day the river may not be meeting the criteria that support a healthy aquatic ecosystem. Additional information about the daily average percent of saturation is needed to determine whether or not the river is meeting the dissolved oxygen percent of saturation standard at this location.

pH
1998-5-0 (unless naturally occurring)

The pH values recorded at 12-Ext ranged from 7.00 to 7.15, all within the standard range for Class B waters.

1999-2-0 (unless naturally occurring)

The pH values recorded in 1999 pH values ranged from 6.54 to 7.00, all within the standard range for Class B waters.

Bacteria
1998-3-1
1999-3-0

Bacteria samples were collected by the DES Ambient Sampling Program and analyzed for *E. coli* bacteria 1998 and 1999, ranging from 190 to 450 *E. coli* CTS/100mL. On August 4, 1998, the sample collected contained 450 *E. coli* CTS/100mL, exceeding the maximum of 406 *E. coli* CTS/100mL. Wet weather in the summer of 1998 may have caused runoff containing *E. coli* bacteria to wash into the river from the shores and or nearby wetland areas. Further investigation into the surrounding watershed is needed to determine the source of the bacteria.

09-Ext. High Street Bridge, Exeter, NH:

Dissolved Oxygen
1998-6-0 (< 5 mg/L minimum)

The DO concentrations at 09-Ext in 1998 ranged from 6.22 to 8.89 mg/L, all above the minimum instantaneous concentration of 5 mg/L. One of the samples collected by volunteers did not have 75% saturation, ranging from 73.6 to 95.8% saturation.

1999-2-0 (< 5 mg/L minimum)

The DO concentrations ranged from 6.26 to 6.5 mg/L in 1999. One of the samples collected by volunteers did not have 75% saturation, ranging from 72.1 to 81.2% saturation.

These readings suggest that for the most part this river segment is meeting the criteria that support a healthy aquatic ecosystem. The instance in which the percent of saturation was not adequate may have been recorded when the river had naturally occurring low-flow conditions. Additional information about the daily average percent of saturation is needed to determine whether or not the river is meeting the dissolved oxygen percent of saturation standard at this location.

pH
1998-6-0 (unless naturally occurring)

The pH values recorded in 1998 ranged from 6.83 to 7.12, all within the standard range for Class B waters.

1999-2-1 (unless naturally occurring)

The pH values recorded in 1999 were between 6.12 and 7.25. One of the measurements taken was below the standard range for pH (6.5 to 8). Drainage from the nearby watershed may be affecting the pH levels in this river segment. Additional investigations into the drainage area are necessary to determine the cause of the low pH levels.

Recommendations

After reviewing the data from the Exeter River, VRAP recommends the following actions:

- Further investigation through shoreline surveys will help interpret the data by providing information about potential impacts to surface water quality. The location of runoff, wetland areas, areas lacking vegetated buffers, and the characteristics of the land adjacent to the river will help confirm and determine the cause of potential and confirmed violations of the water quality standards. This information may then be used to correct problems that are not naturally occurring.

- VRAP suggests the use of Hydrolab® meters at locations in the watershed that exhibited low DO concentrations. A Hydrolab® is a meter that is deployed for a period of days, weeks, or months in the river to measure water temperature, dissolved oxygen, pH, turbidity, and conductivity simultaneously and at set time intervals. This information will help determine if the daily average values of dissolved oxygen are supporting aquatic habitat and if the river segment is meeting surface water quality regulations. The multi-parameter meters can also be placed above and below a suspected pollution source to determine the impact.

  VRAP can loan these multi-parameter meters, and suggests placing them at 12-Ext and 09-Ext during the summer of 2000. A Hydrolab® may also be placed in tributaries to the Exeter River to produce additional information about the quality of the water coming into the main channel.

- Additional investigations into sources of bacteria in the watershed are recommended at 12-Ext where potential bacteria violations were documented. Relationships with the municipalities in the watershed should be cultivated to accomplish bacteria analysis at a local laboratory. Volunteers seeking additional experience with analyzing water samples may consider offering to work in a municipal lab filtering and incubating samples. VRAP is capable of providing equipment that may be necessary to accommodate the extra sample load in the laboratory.

- Reducing phosphorus inputs to the river can be accomplished by public education and outreach in the watershed. Waste Water Treatment Facilities (WWTFs) discharge phosphorus to the river. If the communities connected to a municipal waste disposal system reduce the amount of phosphorus they discharge to the WWTF, there would be less discharged to the river. The DES Pollution Prevention Program can provide educational guidance for groups wishing to do outreach related to waste reduction.

- Volunteers can investigate the conditions behind dams on the river and determine if the water meets water quality standards by measuring dissolved oxygen at several locations and depths behind dams. The top 25% of the water depth behind a dam in New Hampshire is required to have a daily average of at least 75% saturation. Measurements recorded by volunteers suggest that the river may not be meeting the required DO criteria at 09-Ext. Investigations of the impoundments in the watershed will help DES determine if standards are being met.

- VRAP encourages the continuation of the effort to monitor baseline conditions in the Exeter River and the expansion of the monitoring outside the Town of Exeter. The sampling that has taken place so far has helped create the recommendations in this report. Additional sampling will augment the data collection and river management efforts of DES, as well as those of local decision makers.

- DES expects annual allocations of federal funds through the Clean Water Action Plans program created under President Clinton's administration. These funds can be used to implement restoration projects that address degraded waters found throughout the coastal watersheds. All volunteer groups in the 43 seacoast communities are encouraged to develop restoration projects. The New Hampshire Estuaries Project Management Plan is an excellent source of project ideas and DES is available to assist watershed groups in developing projects. Contact Natalie Landry, Coastal Watershed Supervisor at 271-5329 for assistance.